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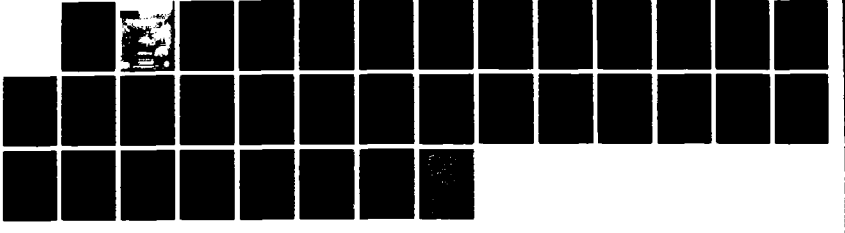

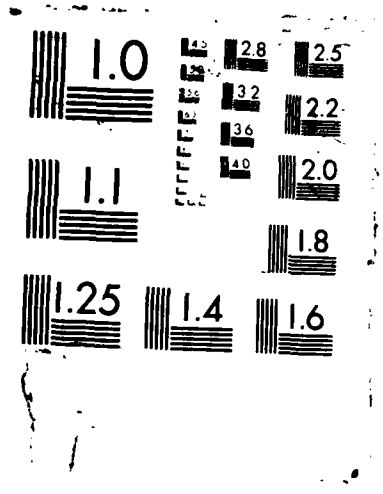
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DIETARY FACTORS RELATED TO PHYSICAL FITNESS*

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Summary

Problem

Changes in our dietary pattern over the last 100 years--greater intake of calories, fats, and sugar, and lower consumption of fiber-rich carbohydrates--have contributed to the rise in degenerative diseases and malignancies common to middle life and old age. A growing body of research also indicates the importance of diet to physical and mental performance. While improved nutrition and nutrition education are integral to the Navy's Personal Excellence Program, neither the current dietary practices of Navy personnel nor the effects of habitual dietary choices on physical fitness are known.

Objective

The specific objectives of this study were to (a) provide a general description of selected dietary habits of a group of Navy men, (b) describe associations among these habits, and (c) examine the relationship between dietary practices and physical fitness test performance.

Approach

Participants were 1013 men (mean age=26.2 years) stationed aboard 9 Navy ships. The men completed a self-report survey of their lifestyle and dietary habits and were evaluated on four tests of physical fitness: 1.5-mile Run time, number of Sit-ups completed in 2 minutes, Sit-reach flexibility test, and Percent Body Fat. A standardized Overall Fitness score was also computed for each person. Relationships among 11 dietary variables and the five fitness scores were examined.

Results

Reported dietary choices indicated that the men tended to skip breakfast, ingest moderate amounts of caffeine, and favor a high-fat, low-fiber diet. Fitness scores were associated with a number of dietary variables. Overall Fitness, for example, was positively correlated with eating breakfast, eating a low-fat, high-fiber diet, and being oriented

toward good nutrition; fitness was negatively correlated with overeating and caffeine intake. The most consistent predictor across all of the fitness measures was the composite variable indicating an orientation toward good nutrition. Diet was a significant predictor of physical fitness even after controlling for age, exercise, and smoking.

Conclusions

Although diet was found to play a unique role in the physical fitness of these men, the reported dietary habits of the sample fell short of recommended nutritional guidelines. As the most useful predictor of fitness was having a positive nutrition orientation, the establishment of a general awareness and personal concern for one's nutrition might be an efficient and effective means of improving eating habits. The research is currently being extended to include women and shore-based men in a Navy-wide longitudinal study.

Dietary Factors Related to Physical Fitness

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Introduction

Numerous studies and reviews have been published documenting the role of diet and nutrition in health and disease development. Changes in our dietary pattern over the last 100 years--greater intake of calories, fats, and sugar, and lower consumption of fiber-rich carbohydrates--have contributed to the rise in degenerative diseases and malignancies common to middle life and old age (Walker, 1968). Diet has also been shown to affect physical and mental performance. This paper reviews some of the major findings relating dietary factors to health and performance, then addresses the specific question of whether dietary practices are related to physical fitness among military personnel.

Food Elements as Risk Factors

With certain exceptions, dietary-based nutritional deficiencies are relatively rare among Americans. The principal nutrition-related health problems are due instead to the overconsumption of certain food elements, particularly saturated fats, cholesterol, and sodium (Joint Nutrition Monitoring Evaluation Committee, 1986). It is estimated that at least 80 percent of the population eats a diet sufficiently high in saturated fats to increase the risk of developing heart disease and cancer (Havas & Walker, 1986). Strong associations have been found between intake of saturated fats and cholesterol, plasma cholesterol levels, and morbidity/mortality due to atherosclerosis (Dawber, 1980; Havas & Walker, 1986; Hegsted, McGandy, Myers, & Stare, 1965; Joint Nutrition Monitoring, 1986; Keys, Anderson, & Grande, 1965; Nutrition Monitoring, 1986; Shekelle et al., 1981; Truswell, 1985). Saturated fats have also been implicated in cancer of the prostate, breast, and colon (Bosland, 1985; Graham & Mettlin, 1979; Kroes, Beems, Bosland, Bunnik, & Sinkeldam, 1986; National Research Council, 1982). While the case against sodium is not as overwhelming as that against saturated fats, the

deleterious effects of sodium on hypertension are well-known, and researchers continue to probe the possible causal role of salt intake in the development of high blood pressure (Dahl, 1972; Morgan, Carney, & Wilson, 1975; Srinivasan et al., 1980; Tobian, 1979).

Several other dietary risk factors have been identified in addition to fats, cholesterol, and sodium. Sugar is known to cause dental caries (Bierman, 1979). Alcohol has been implicated in a number of diseases, including hypertension (Klatsky, Friedman, Siegelaub, & Gerard, 1977), liver disease and malnutrition (Lieber, 1979), though moderate intake has also been associated with good health (Wiley & Camacho, 1980). Coffee has been linked with bladder cancer (Cole, 1971; Marrett, Walter, & Meigs, 1983), fibrocystic breast disease (Ernster, Mason, Sacks, & Selvin, 1981), and possibly heart disease, via the mechanism of elevated serum cholesterol (Thelle, Arnesen, & Forde, 1983), although Dews (1982) notes that such associations are weak and the evidence inconclusive. Inadequate dietary fiber has recently become a widespread concern, especially with respect to colorectal cancer (Graham & Mettlin, 1979; Kroes et al., 1986; National Cancer Institute, 1984), but also as a possible causal factor in diverticular disease, hemorrhoids, appendicitis, and even ischemic heart disease (Burkitt, Walker, & Painter, 1974).

Meal Patterns and Health

There is substantial agreement that the over or underconsumption of certain food elements is associated with particular diseases. Eating patterns and meal frequency have also been examined for their relationships to health, but the findings have not been clear-cut. Eating breakfast and avoiding between-meal snacks were two of the seven "good health practices" associated with general health status and mortality risk in the Alameda County study (Belloc, 1973; Belloc & Breslow, 1972; Breslow & Enstrom, 1980). Mittleman (1984) maintains that a balanced breakfast is essential for oral health, most notably for preventing gum disease. And between-meal snacking, especially when the snacks are sugary, is known to have a direct relationship to the incidence of dental caries (National Center for Health Statistics, 1981). However, in a 9-year follow-up of the Alameda cohort, Wiley and

Camacho (1980) found that breakfast and snacking were not significantly associated with overall health outcomes, a finding corroborated in a separate cross-sectional study by Metzner, Carman, and House (1983). Moreover, there is evidence that "nibbling", or ingesting the daily food allotment in several small meals throughout the day, rather than at one, two, or three main meals, can have a beneficial effect on serum cholesterol, blood lipids, and blood sugar level (Cohn, 1964; Fabry & Tepperman, 1970; Gwinup, Byron, Roush, Kruger, & Hamwi, 1963; Wadhwa, Young, Schmidt, Elson, & Pringle, 1973).

Diet and Performance

A related body of research has examined the impact of dietary practices and nutritional intake on performance, both mental and physical. Again, the value of eating breakfast has been of special interest. Tuttle and his colleagues (Tuttle & Herbert, 1960; Tuttle, Daum, Larsen, Salzano, & Roloff, 1954) reported a significant reduction in work rate and work output in both adults and school children who had not eaten breakfast, and Pollitt, Lewis, Garza, and Shulman (1982/83) found that children's problem-solving ability was adversely affected by skipping breakfast. Other studies have reported reduced physical efficiency (Haggard & Greenberg, 1935) and higher accident rates (Brooke, Toogood, Green, & Bagley, 1973) among adults who have not eaten a morning meal. Nevertheless, after reviewing the literature relating breakfast to performance, Dickie and Bender (1982) concluded that there was little methodologically sound evidence that skipping breakfast is detrimental to performance.

The evidence relating meal composition to performance is more conclusive. While athletes and other individuals often prefer meals high in protein, it is carbohydrates, and to a lesser degree fats, that provide fuel for working muscles (Astrand, 1967; Consolazio & Johnson, 1972). In studies of prolonged work, Christensen and Hansen (cited in Bergstrom, Hermansen, Hultman, & Saltin, 1967) found that men consuming a high-carbohydrate diet for several days prior to performance testing were able to work up to three times longer than men who had been on a high-fat diet for several days. Expanding on these results, Bergstrom et al. (1967) found that a subject could perform a standard bicycle ergometer test for nearly three hours

following a high carbohydrate diet, but only two hours on a normal mixed diet, and barely one hour on a fat and protein diet. Yet the average American diet contains about twice the recommended amount of protein, much of it from animal sources (Joint Nutrition Monitoring, 1986). Not only does this represent an unnecessary source of saturated fats, but laboratory findings suggest that excessive protein intake may be associated with increased risk of certain cancers (National Research Council, 1982).

Non-nutritive substances such as alcohol and caffeinated coffee are ubiquitous components of the American diet which affect performance as well as health. Alcohol measurably impairs performance, particularly reaction time. It is considered dangerous and even illegal to operate machinery under the influence of alcohol, and its chronic consumption is regarded as a disorder. Caffeine, on the other hand, is a performance-enhancer (Costill, Dalsky, & Fink, 1978) whose stimulating effects during prolonged exercise and physical exhaustion are so well established that the International Olympic Committee has banned its use in competitive games (Hatfield, 1986). Little is known about the effects of habitual caffeine consumption, however. While the main benefit of caffeine is in restoring normal performance that has been degraded by fatigue or boredom (Dews, 1982), Lane (1983) demonstrated that moderate doses of caffeine elicited a rise in blood pressure in healthy young men. Further, caffeine significantly augmented the cardiovascular and hormonal effects produced by stress. A methodological problem in caffeine research is the equation of caffeine with coffee, ignoring two other popular sources of significant amounts of caffeine, namely, caffeinated tea and soft drinks (Dews, 1982; Timson, 1971). This equation can produce error not only in estimating caffeine intake, but in interpretating results as well, since coffee, including decaffeinated, has been found to contain another psychoactive substance besides caffeine (Boublik, Quinn, Clements, Herington, Wynne, & Funder, 1983).

Study Objectives

This broad body of research indicates the importance of diet to health and physical performance. These factors are particularly salient to the U.S. armed forces, where high levels of physical and mental performance are needed to ensure "combat readiness." In fact, the Navy has several programs

oriented toward enhancing the "personal excellence" of Navy personnel (Watkins, 1986), and enhanced physical fitness and better nutrition are integral to this effort. The present study examined the relationship between everyday dietary practices among Navy shipboard personnel and performance on four tests of physical fitness. The specific objectives of the study were to (a) provide a general description of selected dietary habits of a group of Navy men, (b) describe associations among these habits, and (c) examine the relationships between dietary practices and physical fitness test performance.

Method

Subjects

Participants were volunteers in a larger study designed to evaluate physical readiness among male shipboard personnel (Conway & Dutton, 1985). The present study examined data from 1013 men for whom both physical fitness test scores and lifestyle questionnaire responses were available. These men were stationed aboard nine Navy ships (three amphibious warships, two destroyers, two frigates, one cruiser, and one aircraft carrier), all of which were home-ported in San Diego, California, at the time of the study. Enlisted personnel comprised the majority of the sample (93%), and the median paygrade was E-4; however, all paygrade levels from recruit through commander were represented. Mean age of the group was 26.2 years (SD=6.3), with a range of 18-51 years. Ninety-four percent were high school graduates, and 25% had attended college. Racial composition of the sample was predominantly White (78%); Blacks accounted for 10%, and the remaining 12% were Hispanic, Malayan, Filipino, Puerto Rican, Asian, or "Other."

Measures

Lifestyle Questionnaire. Participants completed a self-report "lifestyle" survey concerning health-related behaviors, attitudes, and perceptions. This study focused on the dietary practices reported in the questionnaire. Sample sizes for the different items varied somewhat because three different forms of the questionnaire were randomly distributed to the subject pool. The majority of the dietary items were contained in two forms and were answered by approximately 620 of the participants. Questions concerning general nutrition attitudes and behaviors, as well as those on

substance consumption (e.g., coffee), were common to all three forms and were answered by approximately 995 respondents.

Dietary variables. The study focused on eleven dietary variables: six individual items concerning eating patterns and frequency, two computed variables indicating the amount of caffeine and alcohol consumed, two composites of items regarding food choices and meal composition, and one composite of items reflecting a general concern for one's nutrition. These eleven variables and the questionnaire items comprising them are listed in Table 1; reliability coefficients are included for the three scaled variables.

Eating patterns: The first six variables on Table 1 (Breakfast, Lunch, Dinner, Snacking, Overeating, and Fasting) were answered on a multi-point scale of short time ranges: "Less than 1 time" during the previous week, "1-2 times," "3-4 times," "5-6 times," and "Every day" during the previous week.

Food choices: Response scale for the habitual food choice items which make up the "Healthy Diet" (low fat, high fiber and fresh produce) and "Poor Diet" (high fat, low fiber, high sugar and salt) composites was the same as for eating patterns, except that it included two more alternatives: "Twice every day" and "3 or more times every day" during the previous week.

Nutrition orientation: Statements comprising the "Nutrition Orientation" composite were answered on a 5-point Likert-type scale, from "Not at all like me" to "Very much like me".

Caffeine and alcohol: Weekly alcohol consumption was calculated by multiplying the reported number of days on which the respondent drank alcohol by the usual number of drinks taken on those days. Respondents answered three separate questions concerning the average number of caffeinated soft drinks, cups of caffeinated coffee, and cups of caffeinated tea they consumed daily. Total caffeine intake, in milligrams, was estimated for each person using a table of caffeine content of selected foods (Pennington & Church, 1985, p. 223): a cup of coffee was assigned 100 mg of caffeine, a cup of tea, 50 mg, and a 12-oz. cola, 45 mg. Average daily caffeine intake was computed by multiplying the reported number of cups or drinks of each beverage by the appropriate number of milligrams of caffeine, then summing across all three beverages.

Table 1

Items Comprising the Eleven Dietary Variables

Variable Label	Items
1. BREAKFAST	"During the last 7 days, how often did you eat breakfast?"
2. LUNCH	"During the last 7 days, how often did you eat lunch?"
3. DINNER	"During the last 7 days, how often did you eat dinner?"
4. SNACKING	"During the last 7 days, how often did you snack between meals?"
5. OVEREATING	"During the last 7 days, how often did you overeat?"
6. FASTING	"During the last 7 days, how often did you fast an entire day?"
7. CAFFEINE	"During the last 7 days, on the average how many cups of caffeinated coffee, tea, cola drinks did you have per day?"
8. ALCOHOL	"During the last 7 days, on how many days did you have any alcoholic beverages?" "On the days you drank, how many drinks did you usually have per day?"
9. HEALTHY DIET (alpha = .77)	"During the last 7 days, how often did you...? a. eat lean meats b. eat low-fat dairy products c. cook with polyunsaturated oils or margarine d. eat fruits e. eat vegetables f. eat high-fiber bread, grains
10. POOR DIET (alpha = .73)	"During the last 7 days, how often did you...? a. eat high-fat meats b. eat high fat dairy products c. eat food with saturated fats, butter, lard d. eat eggs e. eat refined sugar products f. add salt to your food
11. WEIGHT CONSCIOUS (alpha = .72)	How well does each statement describe you? a. I eat a balanced diet. b. I watch my weight. c. I limit my intake of foods like coffee, sugar, fat, etc. d. I take vitamins. e. I take health food supplements (e.g., brewer's lecithin, wheat germ)

Other variables related to physical fitness. In addition to the eleven dietary variables described above, three nondietary variables known to affect physical performance were examined in some analyses. These were the respondent's age, smoking behavior, and exercise habits.

Smoking: Participants were asked whether they were current, former, or nonsmokers, and if current smokers, how many cigarettes, cigars, or pipes they smoked per day.

Exercise: An estimate of total kilocalories expended per week in physical exercise was also computed for each person. Respondents were given a list of eight forms of physical activity (running, bicycling, swimming, racket sports, walking, aerobics, calisthenics, and weight lifting) and asked to estimate (a) how many times per week they engaged in that activity (frequency), and (b) how much time they generally spent in one workout period for each activity (duration). Kilocalories expended per minute were assigned to each activity, using the tables of energy expenditure in McArdle, Katch, and Katch (1986, pp. 642-649). The number of kilocalories required for each exercise was multiplied by the total time in minutes per week that the respondent reported engaging in that activity (frequency X duration), then summed across all activities for a weekly estimate of energy expenditure.

Physical Fitness Test. All personnel were evaluated on a four-part test of physical fitness and body composition as mandated by Navy regulations (Department of the Navy, 1982). Each command supervised its own fitness testing, following standardized procedures set forth in the Navy instruction. The four test components were as follows:

1.5 mile Run. The Run tested stamina and cardiorespiratory endurance. Performance was scored as the time required to run a distance of 1.5 miles on a reasonably flat, even surface. Participants generally ran in a group (though they were spotted and timed individually) and were allowed to combine walking with running if necessary to complete the course.

Sit ups. This test of muscular endurance was scored as the number of sit-ups completed in a two-minute period. Participants lay flat on their backs with knees bent, heels about 10 inches from the buttocks, and arms folded across the chest. While a partner held his feet to the ground, the man being tested curled up to touch elbows to thighs, then lay back down, touching shoulders to the floor. This constituted one sit up.

Sit-reach. The Sit-reach test of flexibility was performed sitting on the floor with legs straight out and feet spread six inches apart. Scores indicated the positive or negative distance (in inches) from the heel that

one could reach by leaning forward, without bouncing or bending the knees, and touching the floor between the feet with the fingertips, holding the position for at least 3 seconds.

Percent Body Fat. An estimate of body composition (percent fat) was computed from body circumference measures, using equations developed by Wright, Dotson, and Davis (1981). Circumferences were obtained with a standard tape measure applied around the neck just below the larynx, and around the abdomen at the navel, either against bare skin or over very light clothing. The individual being measured stood in a relaxed upright posture during the measuring procedure.

Overall Fitness. In addition to raw scores obtained by the above procedures, an Overall Fitness score was computed for each individual, using the mean of the standardized z scores for each test. Because high scores on the Sit-ups and Sit-reach tests indicated better performance, while high scores for the 1.5-mile Run and Percent Body Fat reflected poorer performance, the signs on the z scores for Run and Body Fat were reversed before calculating the overall mean. This procedure was done so that higher Overall Fitness scores would indicate, on the average, better performance on the fitness tests.

Results

General Dietary Habits

Eating patterns for the group are presented in Table 2. Fifty-two percent of the respondents reported that they frequently skip breakfast (eating breakfast two days a week or less), while only 11% usually miss lunch, and only 4% often skip dinner. Despite the large number of men who skip breakfast, only 26% habitually snack between meals (5-7 days a week); however, 46% reported overeating at least once a week, with 6% responding that they overeat almost every day. A somewhat surprising 10% reported fasting for an entire day or more during the previous week.

In terms of the nutritional content of their meals (Table 3), the respondents favor foods high in saturated fats. Almost twice as many men reported eating at least one serving a day of high-fat meats as reported eating lean meats (23% and 13%, respectively), and nearly four times as many consume high-fat dairy products every day as choose low-fat dairy foods (37%

and 10%, respectively). In addition, half again as many respondents cook with saturated fats (21%) as opposed to polyunsaturated fats (14%) on a daily basis. Cholesterol intake in the form of eggs is also rather high, with 42% eating eggs three times a week or more. Less than half of the sample (49%) consume vegetables on a daily basis, less than one-third (31%) eat fruit every day, and only one-fifth (20%) have at least one serving of high-fiber grains or bread each day. However, 43% of the respondents said that they seldom or never eat refined sugar products, and 42% rarely or never add salt to their food at the table.

Caffeine and alcohol consumption are reported in Table 4. While only 57% of the sample reported drinking coffee, 82% said that they drink caffeinated soft drinks. When all three forms of caffeinated beverages are taken into account, 94% of the men reported ingesting caffeine, the mean amount being 432 mg/day (SD=457 mg/day)--equivalent to 4-5 cups of coffee or 9-10 caffeinated sodas. Because the distribution of total milligrams of caffeine consumed was positively skewed (ranging from 0 to 2720 mg/day), the median amount was considerably lower: 280 mg/day, or about 3 cups of coffee or 6 sodas.

Table 2

Eating Patterns Reported for a 1-Week Period

(Percent of Sample in Each of Five Frequency Categories)

Variable[a]	Number of Days per Week				
	0	1-2	3-4	5-6	7
EAT BREAKFAST	21	31	20	14	14
EAT LUNCH	1	10	23	29	37
EAT DINNER	0	4	17	26	53
EAT SNACKS	13	34	27	12	14
OVEREAT	54	32	8	3	3
FAST	90	8	1	1	0

[a] n-count ranges from 609 to 623.

Seventy-four percent of the respondents reported drinking alcoholic beverages. Because alcohol is not available on Navy ships, this figure might underestimate the number of drinkers (vs. nondrinkers) in the sample, depending on whether the men were restricted to the ship during the previous seven days. The majority of those who did drink consumed an estimated two or fewer drinks per day (number of drinking days X average number of drinks taken on those days/7), though 8% of the entire sample reported drinking an estimated five or more drinks per day (i.e., 35 or more drinks per week). Considering only the answer to the question, "On the days you drank, how many drinks did you usually have per day?" 27% usually had five or more drinks on the days that they drank alcohol.

Table 3

Food Choices Reported for a 1-Week Period

(Percent of Sample in Each of Seven Frequency Categories)

Variable[a]	Number of Times per Week Eaten						
	0	1-2	3-4	5-6	7[b]	14[c]	21[d]
Salt (added to food)	26	16	13	10	11	13	11
High-fat meats	5	21	33	18	14	4	5
Lean meats	7	32	35	13	8	2	3
High-fat dairy	6	19	21	17	16	9	12
Low-fat dairy	50	23	12	5	5	2	3
Saturated fats/butter	20	21	26	12	13	4	4
Polyunsat.fats/marg.	21	28	25	12	9	3	2
Eggs	24	34	20	9	9	1	3
Sugar (refined)	14	29	26	12	12	4	3
Vegetables	2	7	18	24	24	15	10
Fruit	8	16	23	22	17	8	6
High-fiber bread/grain	17	26	22	15	12	6	2

[a] n-count ranges from 607 to 624.

[b] Once every day.

[c] Twice every day.

[d] Three times every day.

Table 4

Consumption of Caffeinated and Alcoholic Beverages

(Percent of Sample in Each Frequency Category)

VARIABLE[a]	RESPONSE SCALE				
Caffeine	Mean number of cups/drinks per day				
	0	1-2	3-5	6-9	10+
COFFEE	43	20	19	10	8
TEA	81	11	5	2	1
SOFT DRINKS	18	45	26	7	4
	Milligrams of caffeine per day				
	0	45-300	300-500	500-1000	1000+
DAILY CAFFEINE INTAKE	6	48	18	18	10
Alcohol	Number of drinking days				
	0	1	2	3	4	5	6	7
During the last 7 days, on how many days did you have alcoholic drinks?	26	17	17	14	9	8	4	5
	Number of drinks per drinking day				
	0	1-2	3-4	5-7	8-16
On the days you drank, how many drinks did you usually have per day?	26	23	24	16	11
	Average number of drinks per week						
	0	1-3	4-7	8-15	16-20	25-34	35+
WEEKLY ALCOHOL INTAKE	26	15	15	20	10	6	8

[a] n-count ranges from 988 to 1001.

Comparable statistics for men in the general population are available for eating breakfast, between-meal snacking, and alcohol consumption (Schoenborn, 1986). As 99% of the Navy sample fell into the age group of 18-44 years, the following comparisons are with U.S. males 18-44 years of age. Approximately 31% of the men nationwide "rarely or never" eat breakfast--a little more than half the number of Navy shipboard men who skip breakfast five days a week or more (52%). However, if those men in the national sample who eat breakfast only "sometimes" (approximately 25%) are included as frequent breakfast-skippers (i.e., five days a week or more), the figures would be similar: 56% breakfast-skippers nationwide versus 52% Navy. Forty-four percent of civilian men snack "almost every day," which is considerably more than the number of Navy men who do (26%). There are only slightly more drinkers in the shipboard sample (74%) than in the population at large (68%), but the Navy men are heavier drinkers: only 13% of the national sample reported drinking an average of five or more drinks on days that they drank alcohol, versus 27% of the Navy group.

Intercorrelation of Nutritional Habits

Good dietary and health practices tend to be positively correlated among themselves and negatively related to poor health and nutrition habits (Table 5). For example, people who eat breakfast tend to favor a healthy diet, even though breakfast also correlated (less strongly) with poor diet. Breakfast eaters also tend to avoid alcohol, cigarettes, and caffeine, and to engage in nutrition-oriented behaviors and physical exercise. Individuals who frequently overeat also snack between meals, consume a poorer diet, drink alcohol, and tend not to practice nutrition-oriented behaviors; they are less likely to exercise and more likely to fast than are normal eaters. Caffeine consumers tend to skip breakfast; they are not nutrition-oriented and their food choices are poor ones. There was a negative relationship between caffeine consumption and kilocalorie expenditure and a strong association between caffeine intake and tobacco use.

Correlation between Physical Fitness and Dietary Practices

Correlation coefficients between each fitness test and the eleven main dietary variables are presented in Table 6. A general overview of these relationships is provided by considering the standardized Overall Fitness

score: Overall Fitness was positively correlated with eating Breakfast (r=.14), Healthy Diet (r=.10), and Nutrition Orientation (r=.27); it was negatively related to Overeating (r=-.12) and Caffeine intake (r=-.18). All coefficients were significant at $p<.01$ or less. The reader is reminded that higher scores for number of Sit-ups, Sit-reach distance, and Overall Fitness indicate better performance, while higher scores on Run time and Percent Body Fat indicate poorer performance.

Table 5

Intercorrelation of the Eleven Dietary Variables and Age, Exercise, Smoking

Variable[a]	Pearson Correlation Coefficients										
	1	2	3	4	5	6	7	8	9	10	11
1. BREAKFAST	----										
2. LUNCH	.23*	----									
3. DINNER	.16*	.27*	----								
4. SNACKING	-.02	.05	.04	----							
5. OVEREATING	.00	.05	.03	.29*	----						
6. FASTING	-.01	-.15*	-.17*	.02	.09#	----					
7. CAFFEINE	-.10+	-.07#	.08#	.04	.04	.00	----				
8. ALCOHOL	-.13*	.05	-.12+	.08#	.08#	-.07#	.06#	----			
9. HEALTHY DIET	.34*	.17*	.24*	.07=	.04	-.01	.01	.00	--		
10. POOR DIET	.15*	.19*	.10+	.26*	.11+	-.06	.14*	.17*	.47*	--	
11. NUTRITION ORIENT.	.28*	.01	.05	.14*	-.13*	.13*	-.14*	-.15*	.27*	-.13*	---
12. AGE	.03	-.03	.12*	-.19*	.01	-.03	.21*	-.18*	.03	.13*	--
13. EXERCISE	.12*	.01	-.01	-.01	.07#	.00	.11*	.01	.24*	.01	.36*
14. SMOKING	-.19*	-.08#	.00	.02	-.02	.02	.41*	.17*	.09#	.09#	.23*

	12	13	14
12. AGE	----		
13. EXERCISE	-.21*	----	
14. SMOKING	.14*	-.24*	----

[a] n-count for correlations involving variables 1-6, 9, and 11 range from 5[illegible] to 5[illegible]

n-count for correlations among variables 7, 8, and 12-14 range from 911 to 9[illegible]

* $p<.001$

\+ $p<.01$

\# $p<.05$

Table 6

Correlations between Dietary Variables and Physical Fitness Test Scores

Variable[a]	Run[b]	Sit-ups	Sit-reach	% Body Fat[b]	Overall
Breakfast	.13**	.09*	.06	-.10*	.14**
Lunch	.00	.00	-.01	-.03	.01
Dinner	.01	.00	.05	-.06	.00
Snacking	-.11*	.00	-.07	-.05	.05
Overeating	.04	.00	-.11*	.22**	-.12**
Fasting	.07+	-.03	.00	-.04	-.02
Caffeine	.21**	-.17**	-.08*	.02	-.18**
Alcohol	-.05+	-.01	.00	.01	.02
Healthy Diet	-.02	.08+	.05	-.12*	.10*
Poor Diet	-.04	.01	-.11*	-.07+	.00
Nutrition Orient.	-.13**	.27**	.16**	-.14**	.27**

[a] n-count ranges from 559 to 626 for Breakfast through Fasting, Healthy Diet, and Poor Diet; n-count ranges from 845 to 941 for Caffeine, Alcohol, and Nutrition Orientation.

[b] Higher score indicates poorer performance.

**p<.001 *p<.01 +p<.05

Prediction of Physical Fitness from Dietary Practices

Stepwise multiple regressions were computed to determine the unique contributions of the eleven primary dietary variables to physical fitness scores. All eleven variables were allowed to enter the equations predicting each of the fitness measures in a forward stepwise procedure (SPSS, 1983). As shown in Table 7, the tendency to engage in nutrition oriented behaviors (Nutrition Orientation) was the most consistent predictor of physical fitness, entering significantly into all five of the prediction equations. Caffeine intake, between meal Snacking, and Overeating were the next most consistent predictors of fitness scores, each entering into three of the five prediction equations. These four dietary variables combined to produce a

Table 7

Stepwise Multiple Regression of Dietary Variables on Physical Fitness Test Scores

Test	Predictor	R^*	R^2	R^2Ch	B
1.5-Mile Run	Caffeine	.21	.04	.04	.000132
	Snacking	.24	.06	.02	.252681
	Nutr.Orient.	.27	.07	.01	-.350988
	Fasting	.28	.08	.01	.442398
	(Constant)				13.396661
Sit-ups	Nutr.Orient.	.27	.08	.08	5.063155
	Caffeine	.30	.09	.02	-.000650
	(Constant)				40.307362
Sit-reach	Nutr.Orient.	.16	.03	.03	.568455
	Overeating	.18	.03	.01	-.297238
	(Constant)				1.412955
Percent	Overeating	.22	.05	.05	1.262297
Body Fat	Healthy Diet	.25	.06	.02	.139897
	Snacking	.27	.08	.01	-.497674
	Nutr.Orient.	.29	.09	.01	.643628
	(Constant)				17.674328
Overall	Nutr.Orient.	.27	.07	.07	.208307
Fitness	Caffeine	.30	.09	.02	-.000032
	Snacking	.32	.10	.01	.069494
	Overeating	.34	.11	.01	-.088343
	(Constant)				-.630162

* All coefficients significant at $p<.001$

multiple R of .34 for Overall Fitness, the summary fitness indicator. Eating a high-fiber, low-fat diet (Healthy Diet) and skipping meals for an entire day (Fasting) were the only other predictors to emerge in the analysis; the remaining five nutrition variables did not add significantly to the predictive power of the equations.

Because age, exercise, and smoking are correlated with physical fitness (see Table 8), and because these three variables are also correlated with some of the dietary practices (see Table 5), a second multiple regression analysis was computed to determine whether diet made a significant contribution to the criterion measures over and above that made by age, exercise, and smoking (Table 9). For this analysis, Age was forced into the

Table 8

Correlations between Physical Fitness Measures and Age, Exercise[a], and Smoking[b]

	Run[c]	Sit-ups	Sit-reach	% Body Fat[c]	Overall
Age	.38* (989)[d]	-.29* (1005)	-.14* (924)	.23* (988)	-.40* (1011)
Exercise	-.28* (960)	.34* (974)	.18* (896)	.11+ (958)	.35* (980)
Smoking	.31* (965)	-.29* (980)	-.11* (902)	.06+ (966)	.29* (986)

[a] Total kilocalories expended per week.

[b] Average amount of tobacco smoked per day.

[c] Higher score indicates poorer fitness.

[d] n count

* $p<.001$

+ $p<.05$

Table 9

Forced Entry Regression of Age, Exercise[a], and Smoking[b], Followed by Diet[c] on Physical Fitness Test Scores

Test	Predictor	R*	R^2	R^2Ch	SigCh
1.5-Mile Run	Age	.37	.14	.14	.000
	Exercise	.42	.18	.04	.000
	Smoking	.48	.23	.05	.000
	Diet	.51	.26	.03	.014
Sit-ups	Age	.28	.08	.08	.000
	Exercise	.40	.16	.08	.000
	Smoking	.44	.20	.03	.000
	Diet	.48	.23	.03	.010
Sit reach	Age	.15	.02	.02	.001
	Exercise	.23	.05	.03	.000
	Smoking	.23	.05	.00	.252
	Diet	.30	.09	.04	.034
Percent	Age	.22	.05	.05	.000
Body Fat	Exercise	.23	.05	.00	.123
	Smoking	.23	.05	.00	.764
	Diet	.38	.14	.09	.000
Overall	Age	.39	.15	.15	.000
Fitness	Exercise	.48	.23	.08	.000
	Smoking	.51	.26	.03	.000
	Diet	.53	.31	.04	.000

[a] Total Kilocalories expended per week.

[b] Average amount of tobacco smoked per day.

[c] All 12 dietary variables entered as a block.

* All coefficients significant at p≤.001 or less.

equation first, followed by Exercise (total kilocalories expended per week), then Smoking (average number of cigarettes/cigars/pipes smoked per day); the eleven dietary variables were then entered as a block ("Diet"). Diet demonstrated a significant increment in variance accounted for with each of the criterion variables as indicated by the $\underline{R}^2$ change values shown in Table 9. In fact, the unique variance attributable to Diet was greater than that accounted for by any of the other three predictors for Sit-reach and Percent Body Fat, and greater than Smoking in the prediction of Overall Fitness score.

Discussion

Results of the lifestyle survey suggest that the prevailing eating habits of male shipboard personnel are less than optimal for health and fitness, based on the nutritional guidelines provided by such organizations as the American Dairy Council and the American Heart Association. These organizations generally recommend 2-3 servings per day of fruit, 2-3 servings of vegetables, 2 servings of dairy foods, 3-4 servings of bread or cereal products, and 1-2 small portions of lean meat, poultry, or fish. The tendency for these Navy men to eat a high-fat/protein, low-fiber diet is of particular concern, given the growing indications that such a diet might be causally related to cancer and heart disease. For example, epidemiological data indicate that dietary factors are probably the most important determinants of prostatic cancer (Bosland, 1985), which appears to be outdistancing lung cancer as the leading form of cancer in men (Bowen, 1986). Kroes et al. (1986) warn that "consumption of protein (both total and animal protein) and in particular fat (total fat as well as animal fat) are consistently and fairly strongly associated with prostatic cancer. A negative association has been found for vegetables" (p. 138).

A high fat and protein diet has also been shown to be the least effective fuel for physical endurance, while a diet high in complex carbohydrates (fruit, vegetables, whole grains, beans) is the most effective. Americans in general consume about twice the recommended daily allowance of protein, and the Navy's nutritional standard for protein has been set at double the actual RDA requirement in order to "enhance diet acceptability" (Department of the Navy, 1985). The overuse of salt is another instance of

acceptability taking precedence over dietary recommendations, especially where there is heavy reliance on processed foods. While the "safe and adequate" amount of dietary sodium recommended by the National Research Council is 1100-3300 mg, actual intake in the United States is estimated to be much higher--between 5600 and 7600 mg/day (Forbes, 1984)--and the targeted maximum for foods served in military dining facilities is approximately 5500 mg/day for men, 4100 mg for women (Department of the Navy, 1985).

Because researchers have not produced consistent findings on the effects of eating breakfast, the variable Breakfast was examined with particular interest. Considering the zero-order effects, eating breakfast was significantly related to better performance on all of the fitness tests except the Sit-reach. It is particularly noteworthy that body composition tended to be better (i.e., lower percent fat) among breakfast eaters, since dieters frequently skip breakfast in an effort to reduce calorie intake. Breakfast did not emerge as a predictor in any of the regression equations, however. The relatively high correlations between Breakfast and several other variables, most notably Nutrition Orientation (r=.28) and Healthy Diet (r=.34), suggest that most of the variance in physical fitness accounted for by Breakfast was subsumed by other predictors in the regression equations. Furthermore, Breakfast was positively correlated with Poor Diet as well. This might have been because the Poor Diet composite included eggs as a poor food choice, due to their high cholesterol content, and eggs are a popular breakfast item.

The finding that physical fitness scores were negatively correlated with caffeine use appears to contradict much of the research on caffeine and performance. In most studies, caffeine is administered experimentally and has been found to enhance performance, either by restoring a degraded performance to normal levels or by enabling participants to work for more prolonged periods of time. However, the effect of habitual caffeine consumption in daily life has not been addressed except as a possible etiological factor in disease. The present findings suggest that such everyday use might have a negative impact on physical stamina. In fact, caffeine evidenced more negative associations with physical fitness than did alcohol--an unexpected result, even though other researchers have found a

favorable association between moderate alcohol consumption and health (Wiley & Camacho, 1980). A confounding factor is the tendency for poorer health habits to occur together. The co-occurrence of caffeine, alcohol, and tobacco use has been established in other studies (Carmody, Brischetto, Matarazzo, O'Donnell, & Conner, 1985; Istvan & Matarazzo, 1984) as well as the present one, where caffeine use was especially highly correlated with smoking (r=.41). Coffee and cola drinkers were also more likely to skip breakfast, eat poorly, and fail to exercise than those who avoided or limited their caffeinated beverage intake. Although a causal connection between caffeine intake and physical performance decrement cannot be established from the present results, the possibility warrants further investigation.

The regression analysis which forced the entry of age, exercise, and smoking into the regression equations before allowing the dietary variables to enter produced the most compelling evidence that nutrition plays a unique role in the physical fitness of average individuals. It would be expected that a malnourished group of men would show decrements in physical performance, particularly if severe deficiencies in iron, protein, or B-vitamins were present. But the sample under consideration was generally young, healthy, and adequately nourished, with eating habits presumably similar to those of men in the general population. That Diet should nevertheless demonstrate a significant contribution to differences in every one of the fitness measures argues that even the small effects shown in these analyses deserve attention.

It is particularly interesting, in light of the emphasis placed on the role of exercise in weight reduction, that the combined set of dietary variables accounted for more of the variance in Percent Body Fat than did Age, Exercise, and Smoking combined. Certainly these results should not be construed as evidence that exercise is unimportant for weight control. Rather, they underscore the importance of dietary practices in determining body composition. Research supports the role of exercise in reducing fat stores and sparing lean body tissue during dieting (Pavlou, Steffee, Lerman, & Burrows, 1985), but exercise alone is unlikely to effect weight loss if an individual persistently overeats. In the present study, 7% of the participants failed the Percent Body Fat measure. These men also reported

overeating about twice as often as their more normal-weight peers, yet their reported exercise was not significantly less than that of those who passed the body fat standard.

Summary and Conclusions

A growing body of literature has linked dietary factors to a number of diseases, particularly cancer and heart disease. Related research provides evidence that dietary factors affect physical and mental performance as well as health. The present study described the daily nutritional habits of a group of Navy shipboard men, then examined the relationships between these habits and performance on four specific tests of physical fitness. The reported dietary habits of this sample fell short of the basic nutritional practices recommended by many authorities. Furthermore, physical fitness was significantly related to several dietary variables, most notably caffeine intake, between-meal snacking, overeating, and a general nutrition orientation.

While economic and logistical constraints might limit the extent to which the nutritional quality of garrison food can be altered, individual eating patterns can hopefully be changed through education. As both good and bad nutritional practices tend to intercorrelate, the establishment of a general awareness and personal concern for one's nutrition might be an efficient and effective means of improving eating habits. The most useful dietary predictor of physical fitness in the present study was, in fact, *Nutrition Orientation*, a composite reflecting a general tendency to engage in nutrition-oriented behaviors. This composite entered significantly into the regression equations for all five criterion measures (Run, Situps, Sit-reach, Percent Body Fat, and Overall Fitness), and was also significantly related to eating breakfast, avoiding snacks, selecting low fat, high fiber foods, and numerous other healthful dietary practices. If educational efforts were directed toward instilling a basic interest in and concern for good nutrition, this orientation might generalize to a large field of specific dietary habits. In the absence of such a predisposing attitude, knowledge of sound nutritional principles would likely be ineffective in altering eating behaviors (Schwartz, 1975).

Whether the nutritional practices of these men are representative of the Navy at large is a question needing further exploration. Shipboard personnel are generally younger as a group than shore-based personnel (e.g., Conway & Dutton, 1985). Their reliance on mess hall food and their opportunities for physical exercise also probably differ from those of shore-based commands. Furthermore, women, who were not represented in this sample because they are presently assigned only to noncombatant ships, have been found to differ from men in their eating habits (Joint Nutrition Monitoring, 1986), food attitudes (Hollis, Carmody, Conner, Fey, & Matarazzo, 1986), and nutrition knowledge (Abraham, Beumont, Booth, Rouse, & Rogers, 1981). The Naval Health Research Center is currently undertaking a Navy-wide study of health and physical readiness, including a nutritional behavior component, which should help establish the limits of generalizability of the results reported here. Finally, as the Navy's Personal Excellence Program expands to include menu revisions and structured nutrition education, it is hoped that both dietary practices and physical fitness among Navy personnel will change for the better.

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This study examined the relationship between habitual dietary practices and performance on the physical readiness test required of all active duty Navy personnel (OPNAV6110.1B). Participants were 1013 men (mean age=26.2 years) stationed aboard 9 Navy ships. The men completed a self-report survey of lifestyle and dietary habits and were evaluated on four tests of physical fitness: 1.5-mile Run, Situps, Sit-reach, and Percent Body Fat. A standardized Overall Fitness score was also computed for each person. Results indicated that the participants tend to skip breakfast, ingest moderate amounts of caffeine, and favor a high-fat, low-fiber diet. Fitness scores were associated with a number of dietary variables, including caffeine intake, between-meal snacking, and overeating (all negatively related to fitness), and having a general "nutrition orientation" (positively related to fitness). Diet was a significant predictor of fitness, even after controlling for age, exercise, and smoking.

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